

COMMONWEALTH OF PENNSYLVANIA
Department of Transportation

RESEARCH PROJECT NO. 85-103

EVALUATION OF DURISOL SOUND WALL

FINAL REPORT
AUGUST 2000

Prepared by:
JOHN J. HUGHES AND ERIK SOMERS

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
BUREAU OF CONSTRUCTION AND MATERIALS
ENGINEERING TECHNOLOGY AND INFORMATION DIVISION

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PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
BUREAU OF CONSTRUCTION AND MATERIALS
ENGINEERING, TECHNOLOGY AND INFORMATION DIVISION
EVALUATION AND RESEARCH SECTION

IN COOPERATION WITH

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Metric Conversion Factors*

☐ To Convert From:	To:	Multiply By:
Length		
foot (ft)	meter (m)	0.3048
inch (in)	millimeter (mm)	25.4
yard (yd)	meter (m)	0.9144
mile (statute)	kilometer (km)	1.609
Area		
square foot (ft ²)	square meter (m ²)	0.0929
square inch (in ²)	square centimeter (cm ²)	6.451
square yard (yd ²)	square meter (m ²)	0.8361
Volume		
cubic foot (ft ³)	cubic meter (m ³)	0.02832
cubic yard (yd ³)	cubic meter (m ³)	0.00315
gallon (U.S. liquid)	cubic meter (m ³)	0.004546
ounce (U.S. liquid)	cubic centimeter (cm ³)	29.57
Mass		
ounce-mass (avdp)	gram (g)	28.35
pound-mass (avdp)	kilogram (kg)	0.4536
ton (metric)	kilogram (kg)	1000
ton (short, 2000 lbm)	kilogram (kg)	907.2
Density		
pound-mass/cubic foot	kilogram/cubic meter (kg/m ³)	16.02
mass/cubic yard	kilogram/cubic meter (kg/m ³)	0.5933
pound-mass/gallon(U.S.)**	kilogram/cubic meter (kg/m ³)	119.8
pound-mass/gallon(Can.)*	kilogram/cubic meter (kg/m ³)	99.78
Temperature		
deg Celsius (°C)	kelvin (°K)	$t^{°K} = (t^{°C} + 273.15)$
deg Fahrenheit (°F)	kelvin (°K)	$t^{°K} = (t^{°F} + 459.67) / 1.8$
deg Fahrenheit (°F)	deg Celsius (°C)	$t^{°C} = (t^{°F} - 32) / 1.8$

* The reference source for information on SI units and more exact conversion factors is "Metric Practice Guide" ASTM E380.

** One U.S. gallon equals 0.8327 Canadian gallon.

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Executive Summary

This research project evaluates the durability of Durisol noise barriers constructed at three different research sites and manufactured by three different fabricators. Durisol noise barriers were erected in Lehigh County, Lancaster County, and Delaware County, and manufactured by Concrete Safety Systems Inc., Larry E Knight Inc., and Reservco Inc., respectively.

Durisol noise barriers are designed to be aesthetic walls, which function to attenuate the noise produced by motor vehicles. The barriers consist of panels with a sound absorbing face and an aggregate concrete face. The sound absorbing face is constructed primarily of processed wood chips.

Post-construction observations indicate Durisol noise barriers yield a short maintenance free service life. Throughout all three research sites, panels have debonded from the concrete backing, resulting in cracks. Sound absorbing panels at all locations have become friable, causing them to fall apart and making them susceptible to damage caused by wind-blown and tire thrown objects. The unsightly repairs of debonded and damaged panels reduce the aesthetic quality of the Durisol noise barriers. It is unclear how deterioration affects the noise attenuation properties of the Durisol noise wall.

Based on poor performance of the Durisol noise barrier, in 1993 a moratorium was placed on the use of this product. The Durisol noise barrier is not recommended as an approved product for any future Pennsylvania Department of Transportation projects.

Introduction

The purpose of this report is to evaluate the durability of the Durisol noise barrier. This report does not evaluate the noise attenuation properties of the barrier. Durisol, a porous sound absorbent material, is composed primarily of treated wood chips cemented and molded to form panels. The panels make up the sound walls erected on both sides of a highway, which function to attenuate the noise produced by motor vehicles. The Durisol acts to reduce multiple reflections between the parallel barriers on both sides of the highway.

The entire wall is designed to be an aesthetic barrier that is airtight and sound proof. Durisol is advertised as being fireproof and being resistant to natural elements, insect infestation, road-deicing chemicals and to fungicides. In addition, it is advertised that Durisol panels are not sensitive to wind-blown or wheel thrown objects or objects discharged from snow clearing equipment.

Construction Summary

Durisol sound walls were erected in Lehigh County during 1998, in Delaware County during 1991 and in Lancaster County during 1992. Refer to Appendix 1 for the locations of the walls. The sound walls installed in each of the three counties were manufactured by a different fabricator. Concrete Safety Systems Inc. manufactured the sound wall installed in Lehigh County, Larry E Knight Inc. manufactured the sound wall installed in Delaware County, and Reservco Inc. manufactured the sound wall installed in Lancaster County. Table 1 summarizes the Durisol sound walls in each of the three counties.

Table 1 Durisol Sound Walls

County	Engineering District	SR-Section	Construction Date	Fabricator
Lehigh	5-0	1045-300 1045-300 (I-78)	1988	Concrete Safety Systems Inc.
Delaware	6-0	0476-300 0476-500 (I-476, Blue Route)	1991	Larry E Knight Inc.
Lancaster	8-0	6023-B01 (Route 30)	1992	Reservco Inc.

Durisol noise barriers consist of sound-attenuating Durisol panels and posts of steel or concrete, which are poured in concrete footings. Panels are sound absorbing on one face, pre-finished with aggregate concrete on the other. Tongue and groove construction provides an airtight seal along the horizontal joints. See Appendix 2 for a descriptive drawing of the construction of Durisol noise barriers.

Performance Summary

Observation of the Durisol noise barriers in the three counties indicates a tendency for the Durisol panel to debond from its concrete backing. Figure 1 is a photograph from the Lehigh County research site showing two panels completely detached from the concrete backing.

Debonding from the concrete backing can also result in cracking of the Durisol panel because it cannot support its own weight. Refer to Figure 2 for an example of cracks resulting from debonded panels.



Figure 1-Panels detached from the concrete backing



Figure 2-Two cracks caused by panels debonding from the concrete backing

Repair of debonded panels reduces the aesthetics of the Durisol Sound Barrier. Figure 3 shows the repair of the detached panels shown in Figure 1. Often, debonded panels are reattached to the concrete backing via lag bolts. Both the lag bolt holes and cracks are sealed and painted, negatively affecting the aesthetics of the wall. Refer to Figures 2 and 4 to see repairs of debonded and cracked panels. These unsightly repairs can be seen throughout the Lehigh and Lancaster County research sites.



Figure 3- Repair of the detached panels shown in Figure 1



Figure 4-Repair of a debonded panel, which has cracked

The Durisol panels in the noise barriers of all three research sites are susceptible to becoming friable and falling apart. Figures 5 and 6 show an actual spall, which has broken off the Durisol panel in the Lehigh County research site. Figure 7 shows a Durisol panel of the Delaware County research site breaking apart



Figure 5- A surface spall on the lower panel



Figure 6- The actual spall from the above photo



Figure 7-A panel from the Delaware County research site falling apart

The Durisol panels at all three research sites are also susceptible to wind-blown and tire thrown objects. The panel in Figure 8 is from the Delaware County research site and shows damages caused by a wind-blown or tire thrown object.



Figure 8- Damage caused by a wind-blown or tire thrown object

Sections of panel exposed to moisture caused from the build-up of anti-skid material and traffic spray are deteriorating. The deterioration of panels has been observed at all three research sites. Examples of the rotting Durisol panels can be seen in Figures 9 and 10.



Figure 9- Deterioration of a Lehigh County Durisol panel caused by exposure to moisture



Figure 10-Deterioration of a Delaware County Durisol panel caused by exposure to moisture

Efflorescence of free lime leaching through the panels from the concrete backing is evident in the Durisol panels at the Lehigh and Delaware County research sites. The efflorescence of free lime decreases the aesthetics of the Durisol Sound Barrier. View Figure 11 for an example of this condition.



Figure 11-Efflorescence of free lime migrating through the Durisol panel from the concrete backing

Durisol panels are also vulnerable to insect infestation. Portions of the Durisol noise barrier in Delaware County are found to be infested with carpenter ants. Figure 12 shows a photograph of carpenter ant infestation of a Durisol panel.



Figure 12-Carpenter ant infestation of a Durisol panel

Conclusion

Overall, the Durisol noise barrier has performed less than satisfactorily, regardless of the fabricator of the product. There is every indication that the Durisol noise barrier yields a short maintenance free service life, with no means of adequate repair that does not adversely affect the aesthetic qualities of the walls. In 1993, a moratorium was placed on the use of this product due to its poor performance regarding these issues. Appendix 3 shows the letter recommending a moratorium be placed on Durisol noise barriers. Appendix 4 shows a letter indicating the moratorium has been placed on the product.

Throughout the Lehigh County and Lancaster County research sites, panels have debonded from the concrete backing of the barriers, resulting in cracks. The unsightly repair of the debonded panels and cracks with the use of lag bolts and filler can be seen throughout the noise barriers at these locations.

The panels at all three locations have become friable and easily break apart. The friability of the panels also makes them susceptible to damage caused by wind-blown and tire thrown objects. Durisol panels are also vulnerable to carpenter ant infestation. In addition, the portions of the panels exposed to moisture caused by build-up of anti-skid material and tire spray have also begun to rot. The deteriorating panels adversely affects the aesthetic qualities of the wall. It is unclear how the deterioration affects the noise attenuation properties of the noise barrier.

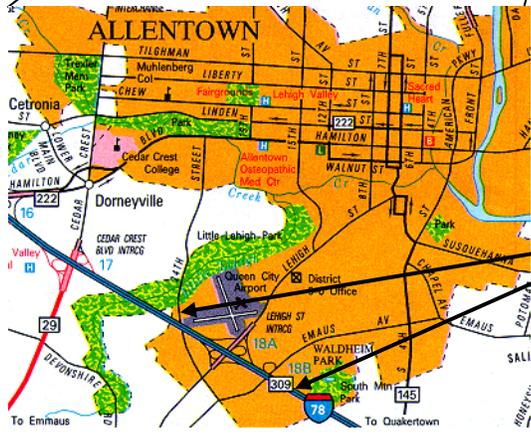
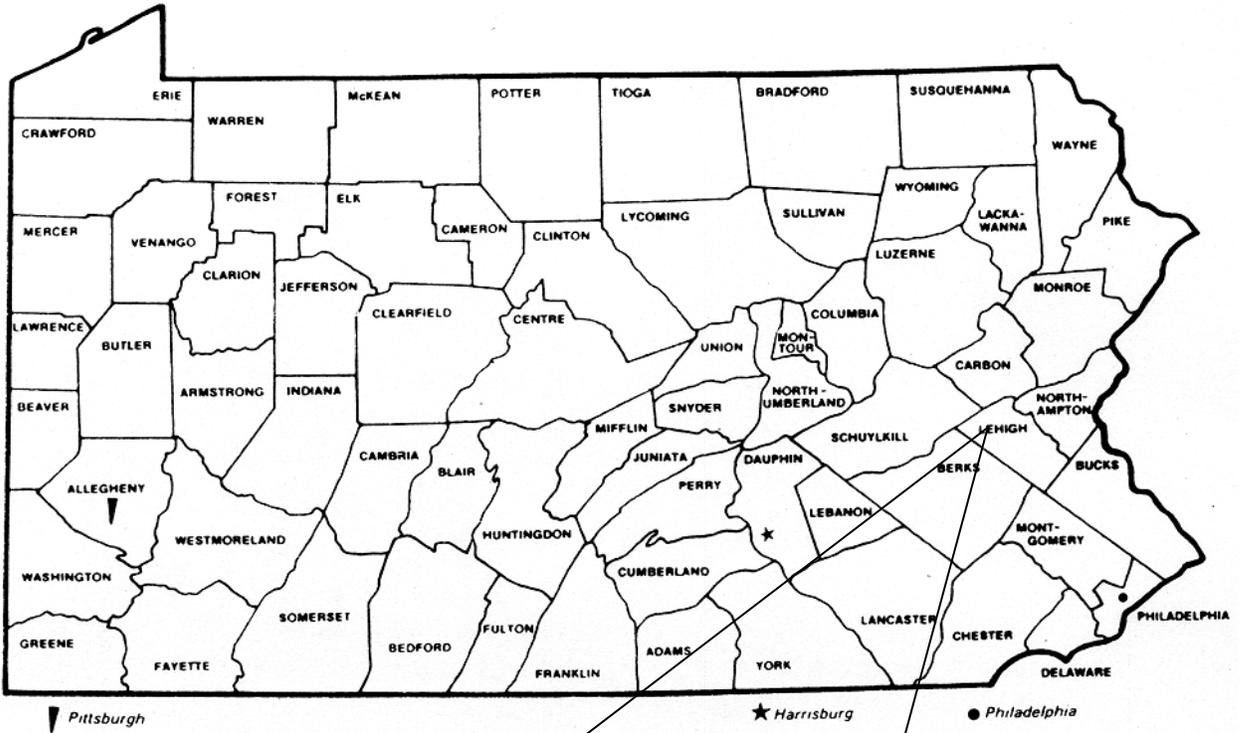
Finally, the leaching of free lime from the concrete backing of the noise barriers, through the wood chip portion of the Durisol panels also reduces the aesthetics of the noise barrier. Appendix 5 contains a collection of photos further illustrating the condition of Durisol noise barriers at the three research sites.

Recommendation

Based on the Durisol noise barrier performance in the Lehigh, Lancaster, and Delaware research sites, the Durisol noise barrier is not recommended as an approved product for any future Pennsylvania Department of Transportation projects.

Appendix 1

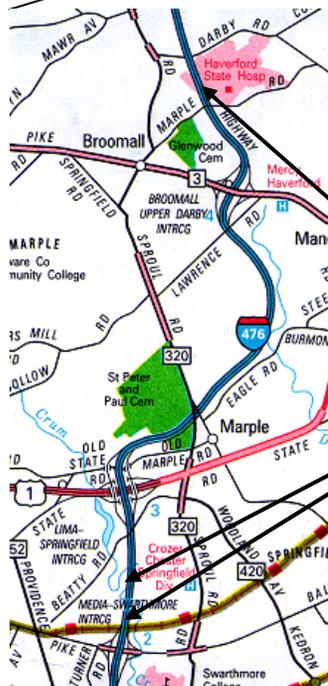
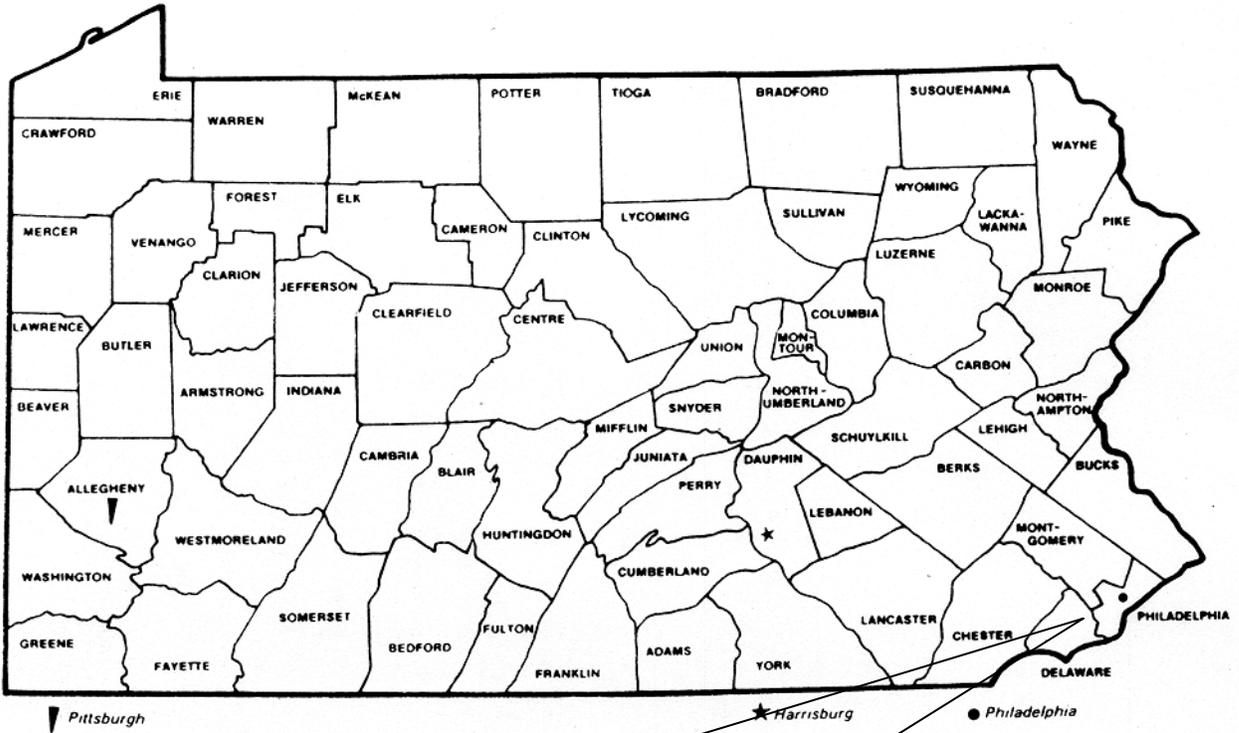
Location Map



Durisol Noise Barriers

Lehigh County

Location Map

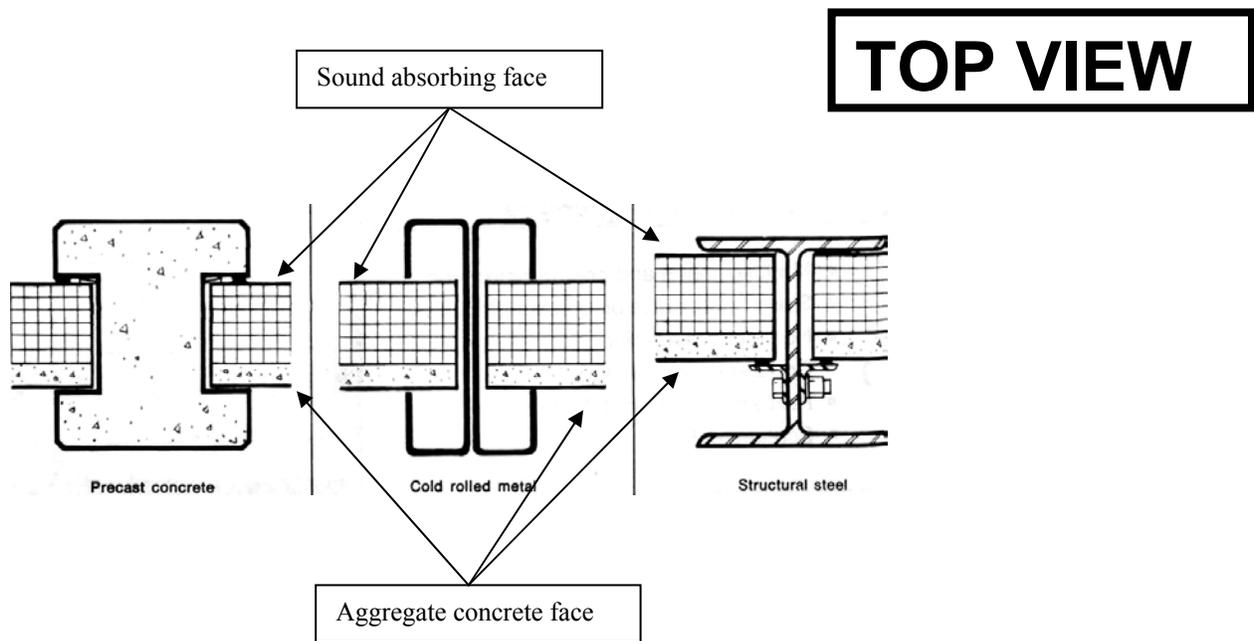
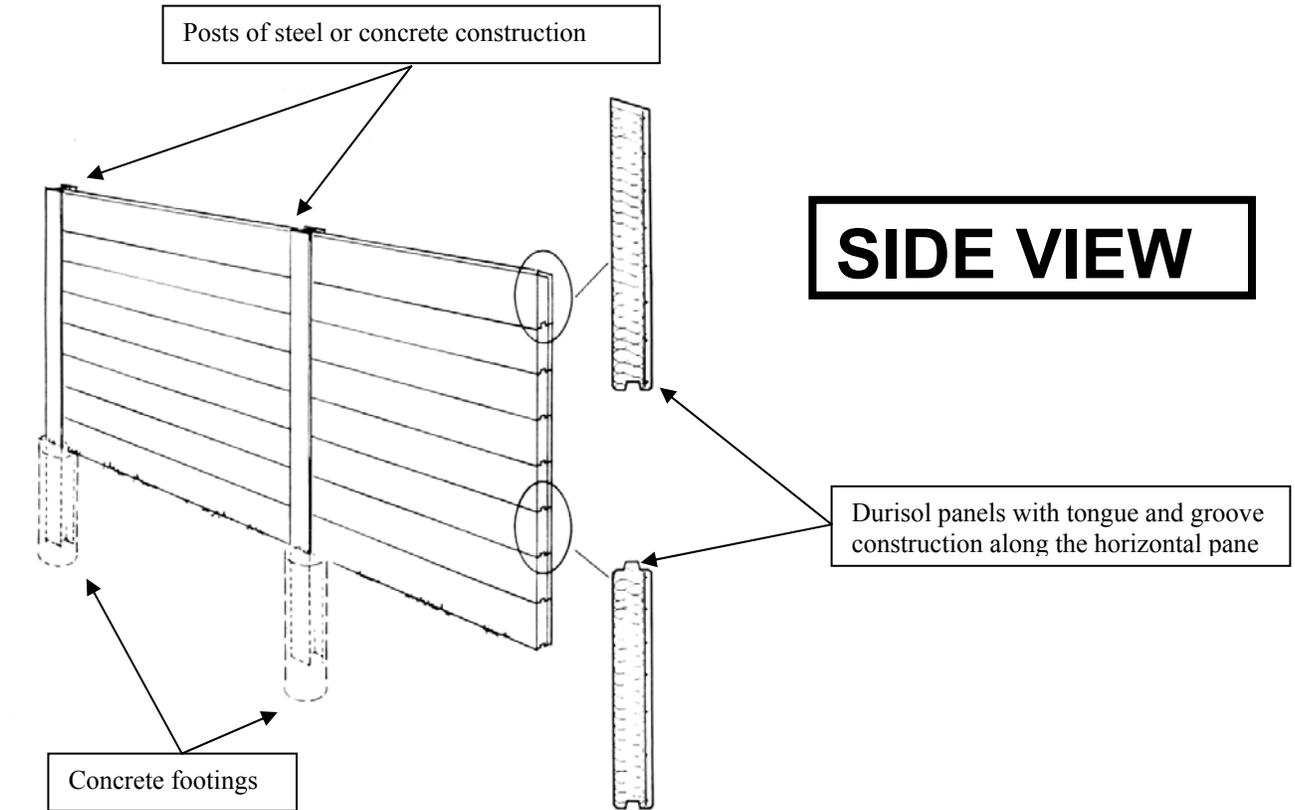


Durisol Noise Barriers

Delaware County

Appendix 2

Construction of Durisol Noise Barrier



Appendix 3

Letter recommending a moratorium be placed on Durisol Noise Barrier

February 12, 1993

Performance Report on Integrated Durisol Sound Wall Panels (Supplier: The Reinforced Earth Co.)

TO: Charles A. Kline, P. E., Chief
Materials Testing Division
Bureau of Construction & Materials

FROM: Dennis A. Moran, P. E., Chief
Structural Materials Engineer
Materials Testing Division

Attached is a pictorial report presentation of numerous deficiencies associated with the DURISOL panel soundwall system.

Based on these findings, it is our recommendation that a moratorium be placed on the DURISOL material until all long term durability concerns are satisfied.

Background:

DURISOL is a porous, sound absorbent material composed primarily of wood chips cemented together and molded under pressure to form panels. As a proprietary licensed material, the Department has been barred from receiving the "waiver" for its manufacture. DURISOL has been used for soundwall panel construction in Pennsylvania for approximately the last five years.

Three projects were reviewed in preparing our report:

County	3P-SECTION
Lehigh	1045-300 1045-500
Lancaster	6023-B01

The Lehigh Co. construction which occurred during 1988 provides a realistic expectation of the DURISOL durability

after five years. Although the Lancaster Co. project was erected only recently during 1992, several fabrication problems indicate a potential for future maintenance considerations.

Item 1 - Porosity

Durisol absorbs sound because it is porous. During the manufacturing process the component ingredients are thoroughly mixed and tamped into a mold. Many of the panels show unsightly efflorescence caused by the leaching of migration of free lime from the concrete portion of the wall through the DURISOL panel while in storage. In addition, depending on the compactive effort used to tamp the material into the mold, varying degrees of surface compaction are achieved. On several occasions, material could be abraded simply by rubbing your hand back and forth across the surface.

Item 2 - Durability

All three projects revealed unsatisfactory durability of the DURISOL panels. Multiple spalls and cracks were encountered in all three projects. In one instance, a construction worker was injured by a falling DURISOL panel. In another instance, workers at Resercco, Inc. were required to patch the DURISOL panel edge spalls immediately prior to shipment.

Another significant durability issue encountered was loss of bond to the concrete wall portion. One of the accompanying photographs shows the panels which have actually delaminated from the concrete wall. The photograph shows a set of car keys inserted between the DURISOL panel edge and the concrete wall. We could actually move many of the panels with very little effort. We have no doubt that at the current rate of deterioration on SR 1045-300, extensive maintenance work will be required in the near future to repair wall panels as they continue to fall off.

It is noteworthy that this anchorage construction is approved practice and was used most recently for the Lancaster Co. project.

Item 3 - Color Consistency/Aesthetics

DURISOL can be produced in any color by adding dyes to the mixture during manufacturing, however, the relative shades are somewhat erratic. The moisture content of the wood chips and the amount of dye added.

Color is particularly critical when patching. Many of the patches on each of the projects contained noticeable differences in color and texture from the surrounding material.

Reservo Co. Inc. was not successful in achieving satisfactory surface color uniformly. The accompanying photographs show the color variations in one of the accompanying photographs caused by placing dark and light colored panels intermittently.

A compromising repair scheme was employed on SR 6023-B01, Lancaster Co. to uniformly cover the efflorescence and color variations. The manufacturer painted the surface which was a color close to the surrounding surface. The manufacturer also indicated the open surface texture designed to entrap the sound.

Summary:

This review illustrates serious durability concerns. The material easily spalls and chips during routine fabrication and yarding operations.

Every indication is that DURISOL will yield a very short maintenance free service life. In the case of SR 1048-100 this may be anywhere from 5 to 10 years which is unacceptable for a wall designed to last 50 years.

Who will make the necessary repairs? Not the Department. As a contractor, we are not given the manufacturing formula to make the repairs ourselves. It is highly unlikely that we could make an attractive repair on an existing spall. After all, the manufacturers can't.

DURISOLI/RDH-FRC/en

attachments-photographs

- cc: J. A. Filippino, P.E.
C. A. Kline, P.E.
M. G. Patel, P.E., Bureau of Design
D. A. Morlan, P.E.
R. H. Green, P.E.
R. H. Horwath
file

Appendix 4

Letter Indicating a Moratorium Has Been Placed On Durisol Noise Barriers

February 24, 1993

Performance of DURISOL
Sound Wall Panels

Mr. Joseph A. Filippino, P.E., Director
Bureau of Construction and Materials

Charles A. Kline, P.E., Chief
Materials and Testing Division

Following the report prepared by Tom Green and Bob Horwhat, we have reviewed the status of approval for DURISOL sound wall panels.

This product has apparently been used in a somewhat uncontrolled manner by designers, since evaluation of the product is incomplete.

Further, we have issued a letter to the Reinforced Earth Company, advising them that a moratorium has been placed on the use of this product by the Department. A copy of the report was enclosed, and they have been given the opportunity to respond to our concerns. In the event they fail to successfully address the evident problems with regards to quality control repair methods, and performance, the product will not be used in the future.

A copy of the report has also been given to Roger Apple, for inclusion in the product evaluation report.

C.K 2/23/93
mm 2-23-93
421/DAM/en
8-447-1951
787-1951
#421678

cc: C. A. Kline, P.E.
D. A. Morian, P.E.
Roger Apple, P.E. ✓
T. H. Green, P.E.
F. C. Flickinger

TICKLE #16

Appendix 5



Photo 1-The fourth panel down in the middle section has debonded from the concrete backing.



Photo 2-Cracked and damaged panels showing efflorescence.



Photo 3-Repair of a debonded and cracked panel.



Photo 4-Repair of a debonded and cracked panel.



Photo 5-Friable panels falling apart.



Photo 6-Friable panels falling apart.



Photo 7-Friable panel falling apart.



Photo 8-A panel damaged by a wind-blown or tire thrown object.



Photo 9-A deteriorating panel exposed to moisture.



Photo 10-A friable panel falling apart.



Photo 11-Durisol panel debonded from the concrete backing in Delaware County



Photo 12-Durisol panel debonded from the concrete backing in Delaware County